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(56) Documents Cited
GB 2295426 A GB 2287290 A GB 2248095 A
GB 2170282 A GB 2136514 A US 4237704 A

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(54) **Pump seals**

(57) A progressive cavity pump is disclosed, the pump having a feed screw 13 mounted on a hollow shaft 15, a pump rotor 17 substantially in line with the feed screw and driven by a rotor shaft 18 passing through the hollow shaft, and a sleeve-like seal 24 extending between the two shafts to seal therebetween. The sleeve-like seal has at least a portion of its side wall formed as a bellows section. The seal is formed of polytetrafluoroethylene, and the bellows section extends at least 50% of the length of the seal. The pitch of the corrugations is smaller than their height.

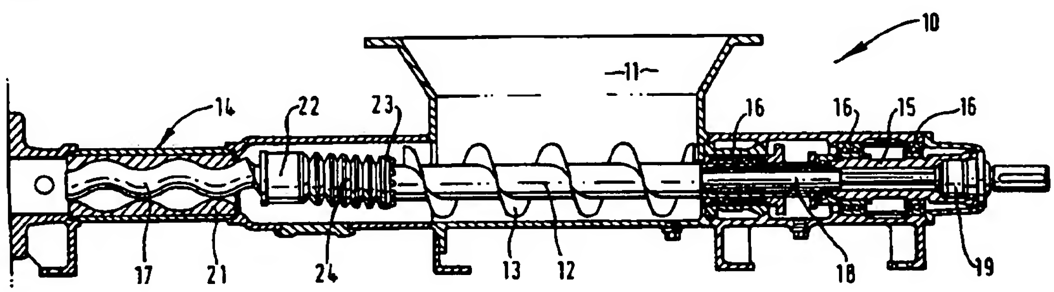

FIG. 1.

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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

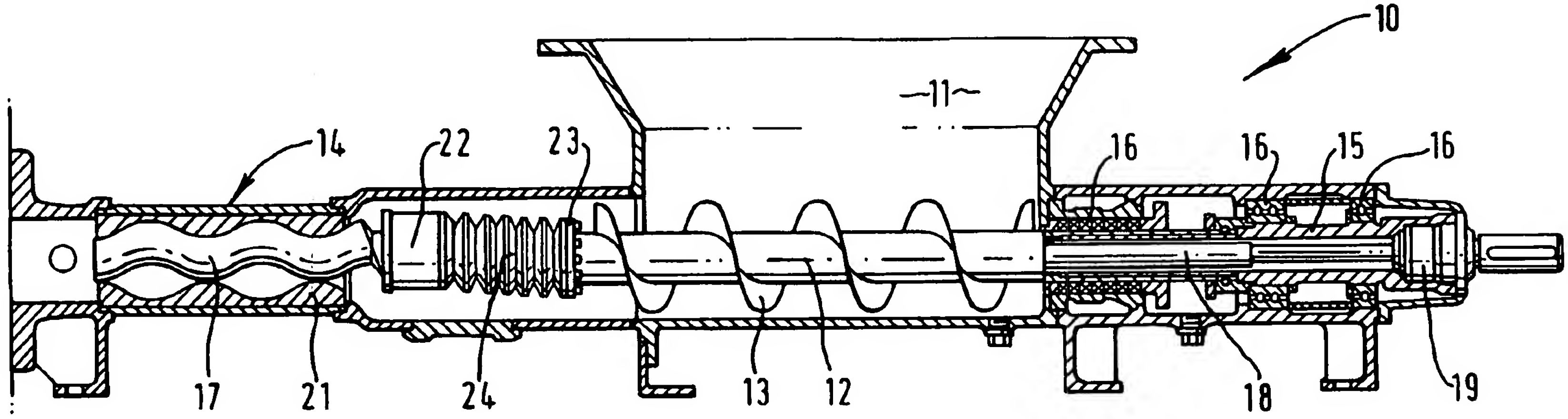

FIG. 1.

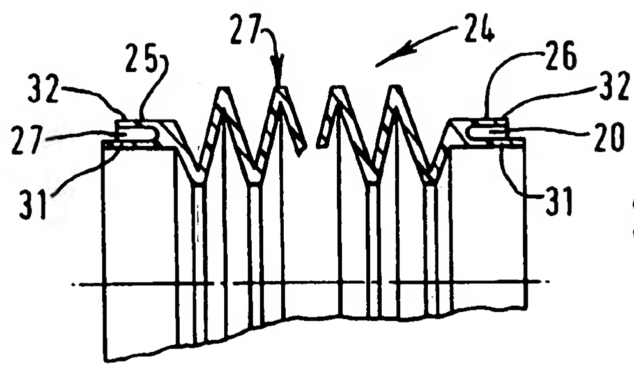

FIG. 2.

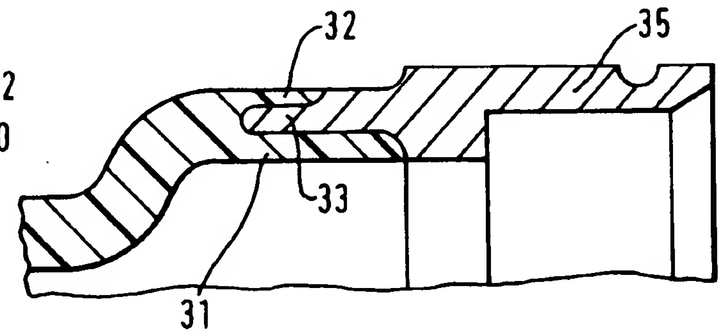

FIG. 3.

PUMPS

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This invention relates to pumps, and in particular to progressive cavity pumps, for example of the type suitable for pumping slurries, pastes, suspensions or semi-solid materials which may or may not be homogeneous.

Examples of paste-like materials, or suspensions, are cellulose containing mixtures, which are well known in various fields of application. In the wood processing and paper making industries there is a need to convey fibre suspensions of pulp having a relatively high consistency (i.e. percentage by weight of dry cellulose material in solution). In other industries such as the textile fibre industry there is the need to convey cellulose-containing solutions to a shaping station where the solution is shaped and subsequently regenerated into a cellulosic product such as films, fibres, tubes or sponges.

In the manufacture of cellulose fibres as described in US-A-4,416,698, the contents of which are hereby incorporated herein by way of reference, there is described a method of producing cellulose filaments from a solution of cellulose in a suitable solvent. Cellulose may be dissolved in a mixture of water and an amine oxide, usually a tertiary amine N-oxide. The water acts to swell the pulp fibres and assists in wetting the fibres with the amine oxide. At elevated temperatures and reduced pressures the cellulose is partially dissolved in the amine oxide/water mixture to form a solution having a relatively high solids content. The partially dissolved cellulose dope is retained at a temperature of about 85-90°C to prevent it from solidifying. At this temperature the cellulose dope still has a high solids content. The partially dissolved material is then transported to a dope forming station. The slurry of amine oxide/water and pulp are described as being transported by means of a progressive cavity pump available from Netzsche Mohnopumpen GmbH. Pumps of this type include an archimedean type feed screw mounted on a hollow shaft with a pump rotor substantially in line with the feed screw and which is

driven by a rotor shaft passing through the hollow shaft. The two shafts are coupled together to rotate in unison, but since the rotor moves eccentrically of its stator, the rotor shaft moves eccentrically within the feed screw hollow shaft. In order to prevent the pumped material from entering the hollow shaft, and at the same time to allow for the eccentric movement of the rotor shaft, a cylindrical elastomeric sleeve-like seal is disposed between the rotor shaft and hollow shaft.

The cylindrical seal is supported internally, against collapse under the pressure of the slurry material, by a coaxial coil spring.

A problem has arisen in that when these known pumps are used for pumping cellulose dope, the seals fail within a short time period (8-12 weeks). This failure is thought to be due partly to the amine oxide operating environment, and partly to contact rubbing of the internal surface of the sleeve on its support spring. Furthermore, the support springs themselves sometime fail, producing broken spring ends that damage the elastomeric seal.

The present invention seeks to provide a seal between the eccentric moving rotor shaft and the hollow shaft of a progressive cavity pump, which has improved life expectancy, especially (but not necessarily exclusively) when operating in an amine oxide environment.

Accordingly there is provided a progressive cavity pump comprising: a feed screw mounted on a hollow shaft; a pump rotor substantially in line with the feed screw and driven by a rotor shaft passing through the hollow shaft; and a sleeve-like seal extending between the two shafts to seal therebetween, the sleeve-like seal having at least a portion of its sidewall formed as a bellows section. Normally, the rotor shaft moves eccentrically with respect to the hollow shaft, as both shafts rotate.

Also according to the invention there is provided a sleeve-like seal for sealing between a pump rotor shaft and a hollow feed screw shaft of a progressive cavity pump of the type in which the pump rotor is substantially in line with the feed screw and the rotor shaft passes through feed screw shaft, the sleeve-like seal having at least a portion of its sidewall formed as a bellows section.

The seal is preferably formed from a fluorinated polymeric material, preferably PTFE (polytetrafluoroethylene).

The bellows section preferably extends for at least 50% of the length of the seal.

The invention will hereinafter be described by way of example only, with reference to the accompanying drawings in which:-

Figure 1 is a longitudinal cross-sectional view of a pump according to the present invention;

Figure 2 is a fragmentary longitudinal section through a seal used in the pump of Figure 1; and

Figure 3 is an enlargement of one end portion of the seal of Figure 2, showing its attachment to an end fitting.

With reference to Figure 1, there is shown a progressive cavity pump 10 which is used as part of the processing system for the formation and transport of a solution of cellulose in an amine oxide based solvent. Apart from the seal, the pump is a normal industrial pump series NP available from Netzsche Mohnopumpen GmbH. Pump 10 is used as a premix pump (that is a pump for the transport of slurry of amine oxide, cellulose in solution and partially dissolved cellulose) in a cellulose dope forming process of the type described in WO94/28216, the contents of which are incorporated herein by reference.

The premix enters the pump through a hopper 11 at the bottom of which there is located an auger 12 having an archimedean screw flight 13 which transports the slurry leftwards, as shown, towards a pump chamber 14.

The auger screw flight 13 is mounted on one end portion of a hollow shaft 15 which is rotatably mounted at the other end portion in axially spaced bearings 16. The pump chamber 14 houses a worm-like pump rotor 17 which is fixed to one end of a shaft 18. Rotor shaft 18 passes through hollow shaft 15 and is connected thereto at its end remote from worm-like rotor 17 by an enclosed knuckle joint 19. The rotor 17 rotates in the pump stator 21 in such a manner that its end adjacent the rotor shaft 18 moves eccentrically relative to the axis of rotation of the hollow shaft 15 and auger 12. The knuckle joint 19 allows for such eccentric movement within the shaft 15. The two shafts 15 and 18 are constrained by knuckle joint 19 to rotate in unison, and are driven by a motor (not shown) attached thereto.

The pump rotor 17 is connected to the rotor shaft 18 by a second enclosed knuckle joint 22, which allows for relative movement between the rotor 17 and the shaft 18.

A sleeve-like seal 24 extends between the second knuckle joint 22 and a radially outwardly projecting flange 23 on the hollow shaft 15, in order to prevent the pumped material from entering the hollow shaft. The seal 24, which in overall form is generally cylindrical, is formed from a relatively stiff fluorinated polymer, preferably PTFE. The two end portions 25 and 26 of the seal 24 are cylindrical and have axially directed annular grooves 27,28 formed in their end faces, thus dividing the end portions 25,26 into spaced concentric inner and outer walls 31, 32. Each of the grooves 27 and 28 is adapted to receive an annular projection 33 of a stainless steel end fitting 35 (only one of which is shown in Figure 3), which secures the seal 24 to the second knuckle joint 22 and to flange 23 respectively.

The PTFE seal may be secured to the stainless steel end fittings by any suitable means, for example by means of adhesive, or by clamping means such as clips, collars or fasteners. If adhesives are used, the PTFE seal must first be chemically etched to render the surface suitable for adhesion. An epoxy resin may for example be used as the adhesive.

The seal may be made by machining a block or rod of sintered PTFE, or may be moulded and sintered.

The mid portion of the seal between the two cylindrical end portions 25, 26 is formed as a bellows section 27. In some cases the cylindrical end portions 25,26 may be extended axially inwardly away from the end fittings 35, in which case the relative length of the bellows section 27 will be reduced. The bellows section 27 should constitute at least 50% of the overall free length of the sleeve seal 24, and preferably between 50% and 85% of the length of seal 24.

The height of the corrugations of the bellows section is about D/5 where D is the outside diameter of the sleeve seal. In a practical example, the outside diameter of the sleeve is about 85mm and the inside diameter is about 55mm. This will give a height of 15mm for the corrugations from trough to peak.

The internal diameter of the bellows section 27 should be chosen so that the seal 24 does not contact the eccentrically moving shaft 18 in operation.

The seal 24 has a nominal overall length of about 134mm and may have up to 10 corrugations in its bellows section. The corrugations have a pitch of about 10mm, so that the pitch of the corrugations is less than their height. The wall thickness of the bellows section is between 1.5-2.5mm, preferably about 2mm.

The combination of the use of corrugations and the use of PTFE provides for a mid-portion which is relatively stiff in the radial direction between end portions 25 and 26, and which should withstand a pressure differential of up to 1 bar ($1.0 \times 10^5 N.m^{-2}$) without any major distortions. The corrugations also allow for flexing in the axial direction. The PTFE material provides for good chemical resistance to the amine oxide environment at elevated temperatures (about 90°C), and will if contacted by the shaft provide a non-wear surface.

CLAIMS

1. A progressive cavity pump comprising: a feed screw mounted on a hollow shaft; a pump rotor substantially in line with the feed screw and driven by a rotor shaft passing through the hollow shaft; and a sleeve-like seal extending between the two shafts to seal therebetween, the sleeve-like seal have at least a portion of its sidewall formed as a bellows section.

2. A pump as claimed in claim 1, wherein the seal is formed from a fluorinated polymer.

3. A pump as claimed in claim 2, wherein the sleeve is formed from polytetrafluoroethylene.

4. A pump as claimed in any one of claims 1 to 3, wherein the bellows section extends for at least 50% of the length of the seal.

5. A pump as claimed in any one of claims 1 to 4, wherein the height of the corrugations in the bellows section is about D/5, where D is the maximum diameter of the bellows.

6. A pump as claimed in claim 5, wherein the corrugations have a pitch which is smaller than their height.

7. A pump as claimed in claim 6, wherein the pitch of the corrugations of the bellows section is between 40% and 70% of the height of the corrugations.

8. A pump as claimed in any one of claims 1 to 7, wherein the bellows section has a mean wall thickness in the order of 2mm.

9. A pump as claimed in any one of claims 1 to 8, wherein the sleeve-like seal has cylindrical end portions

having end faces on its opposite ends, each of which end faces is formed with an annular recess adapted to engage a metal end plate which secures each end of the seal to a respective shaft attachment means.

10. A pump as claimed in any one of claims 1 to 9, wherein the opposite end portions of the seal are each substantially cylindrical for a length of up to 25% of the free length of the seal.

11. A sleeve-like seal for sealing between a pump rotor shaft and a hollow feed screw shaft of a progressive cavity pump of the type in which the pump rotor is substantially in line with the feed screw and the rotor shaft passes through feed screw shaft, the sleeve-like seal having at least a portion of its sidewall formed as a bellows section.

12. A seal as claimed in claim 11, which is formed from PTFE.

Amendments to the claims hav b en filed as foll ws

CLAIMS

1. A progressive cavity pump comprising: a feed screw mounted on a hollow shaft; a pump rotor substantially in line with the feed screw and driven by a rotor shaft passing through the hollow shaft; and a sleeve-like seal extending between the two shafts to seal therebetween, the sleeve-like seal having at least a portion of its sidewall formed as a bellows section.

2. A pump as claimed in claim 1, wherein the seal is formed from a fluorinated polymer.

3. A pump as claimed in claim 2, wherein the sleeve is formed from polytetrafluoroethylene.

4. A pump as claimed in any one of claims 1 to 3, wherein the bellows section extends for at least 50% of the length of the seal.

5. A pump as claimed in any one of claims 1 to 4, wherein the height of the corrugations in the bellows section is about D/5, where D is the maximum diameter of the bellows.

6. A pump as claimed in claim 5, wherein the corrugations have a pitch which is smaller than their height.

7. A pump as claimed in claim 6, wherein the pitch of the corrugations of the bellows section is between 40% and 70% of the height of the corrugations.

8. A pump as claimed in any one of claims 1 to 7, wherein the bellows section has a mean wall thickness in the order of 2mm.

9. A pump as claimed in any one of claims 1 to 8, wherein the sleeve-like seal has cylindrical end portions

having end faces on its opposite ends, each of which end faces is formed with an annular recess adapted to engage a metal end plate which secures each end of the seal to a respective shaft attachment means.

10. A pump as claimed in any one of claims 1 to 9, wherein the opposite end portions of the seal are each substantially cylindrical for a length of up to 25% of the free length of the seal.

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12. A seal as claimed in claim 11, which is formed from PTFE.

The Patent Office

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Application No:	GB 9625504.7	**Examiner:**	Robert L Williams
Claims searched:	1-12	**Date of search:**	13 February 1997

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): F2B

Int Cl (Ed.6): F16J 3/04,15/52 F16D 3/84

Other: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB 2,295,426 A	Draftex Industries Limited	1-8 and 10-12
X	GB 2,287,290 A	Draftex Industries Limited	1-8,11 and 12
X	GB 2,248,095 A	FAG Kugelfischer Georg Schafer KGaA	1-8 and 10-12
X	GB 2,170,282 A	The General Electric Company plc	1-8,11 and 12
X	GB 2,136,514 A	TRW Ehrenreich GmbH 7 Co KG	1-8,11 and 12
X	US 4,237,704	R Varadan	1-8 and 10-12

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